

REMARKS

Claims 15-19 have been canceled and new claims 41-44 have been added. Thus, claims 2, 3, 14, 20 and 37-44 are pending for further prosecution in the present application and claims 21-25 are withdrawn as being directed to a non-elected species but remain in the application in the event that they can be re-joined. Independent claims 2 and 37 have been amended to distinguish over the prior art of record. Applicants respectfully submit that the present application is in condition for allowance.

Claim Rejections - 35 USC §103(a)

A. *In the Non-final Office Action dated October 14, 2009, claims 2, 3, 14, 20, 37 and 38 are rejected under 35 USC §103(a) as being obvious over the publication of Fan et al. titled "Deformation behavior of Zr-based bulk nanocrystalline amorphous alloys" in view of U.S. Patent No. 4,992,095 issued to Nate et al.*

The Fan et al. publication is a three page publication that provides a brief discussion with respect to the mechanical properties of a pair of amorphous alloys. The deformation behavior of the alloys are studied and discussed relative to compression tests applied to specimens of the alloys. Specimens of both alloys are produced by means of melting and casting the alloy. This publication does not relate to the field of sputtering.

One alloy disclosed by Fan et al. is $\text{Zr}_{55}\text{Ni}_5\text{Cu}_{30}\text{Al}_{10}$ which is described by Fan et al. as having a "purely amorphous" microstructure. See page 3762, column on right, lines 8-10 underneath FIG. 2.

The other alloy disclosed by Fan et al. is $\text{Zr}_{53}\text{Ti}_5\text{Ni}_{10}\text{Cu}_{20}\text{Al}_{12}$. The Fan et al. publication discloses that this alloy has an "amorphous matrix" in which a small percentage of nanoparticles are embedded. (See page 3762, column on right, lines 1-4; and see page 3762, column on right,

lines 5-7 underneath FIG. 2.) For example, Table 1 at the bottom of page 3762 discloses five different samples of the alloy with “different volume fractions of nanocrystals” randomly embedded within an otherwise amorphous matrix material. More specifically, Table 1 discloses the alloy having 0%, 10% 16%, 28% and 43% fraction of nanocrystals. Thus, this alloy is essentially amorphous with a small fraction of fine crystals randomly embedded therein.

The disclosure provided by the newly cited Nate patent is entirely different to that of the Fan et al. publication. Nate discloses nothing relative to compression tests of amorphous materials. Rather, Nate discloses a “magneto-optical recording medium” having an entirely different composition, microstructure, and manufacturing method.

The composition of Nate requires 10 to 50 atomic percent of a rare earth metal, 0.1 to 10 atomic percent of at least one additive element (with Zr being specifically referenced), and a balance of a transition metal. None of the specific examples provided by Nate include Zr. Nate clearly provides a teaching that no more than 10at% of Zr should be contained in the alloy (which of courses teaches-away from the present invention and the alloys of the Fan et al. publication).

The microstructure of the material of Nate is required to be a “mixed structure” of different phases of different intermetallic compounds. For example, see the “mixed structures” disclosed on column 2, line 65, to column 3, line 18, of Nate.

With respect to sintering, Nate discloses sintering temperatures of 600°C to 1300°C. See column 4, lines 26-38, of Nate. It should also be noted that Nate fails to disclose sintering powder to produce an amorphous sintered compact; rather, Nate discloses a sintered body having a “mixed structure” of different phases of different intermetallic compounds, not an amorphous sintered body.

Applicants respectfully submit that independent claims 2 and 37 are patentable and are not obvious over Fan et al. in view of Nate. Applicants respectfully submit that the cited references fail to disclose the microstructure required by the claims of the present application and further fail to disclose the unexpected result provided by such a microstructure. In addition, Applicants respectfully submit that one of ordinary skill in the art has no common sense reason for combining or modifying the amorphous alloys of Fan et al. with the alloys of Nate that are required to be a “mixed structure” of different phases of different intermetallic compounds.

Claims 2 and 37 of the present application require a metallic glass alloy sputtering target having a sintered body target structure (i.e. a structure formed of compacted and sintered powder) having an ultrafine and uniform crystal structure with an average crystallite size of 1nm to 5nm. The average crystallite size of 1nm to 5nm is required to be uniform entirely throughout the sputtering target. This microstructure is not disclosed by or obvious from the cited references.

With respect to Fan et al., the $Zr_{55}Ni_5Cu_{30}Al_{10}$ alloy has a “purely amorphous” microstructure, and the $Zr_{53}Ti_5Ni_{10}Cu_{20}Al_{12}$ alloy has a majority of its microstructure formed by an “amorphous matrix” in which a small percentage of nanoparticles are embedded. Thus, while the “purely amorphous” alloy is uniform, it does not possess the ultrafine crystal structure with an average crystallite size of 1nm to 5nm. The other disclosed alloy having a small fraction of nanocrystals embedded in an amorphous matrix does not provide a “uniform” crystal structure and includes only a small fraction of fine particles embedded and separated from one another in an otherwise amorphous material.

In contrast to the present invention and the amorphous materials of Fan et al., Nate discloses a microstructure having a “mixed structure” of different phases of different

compounds. This is certainly not the ultrafine and uniform crystal structure having an average crystallite size of 1nm to 5nm required by the claims of the present application. It should also be noted, that Nate is not a metallic glass and does not include more than 10 atomic percent of Zr.

Accordingly, Applicants respectfully submit that the claimed microstructure is not taught, disclosed, suggested or otherwise made obvious to one of ordinary skill in the art by the cited references.

The microstructure of the present invention provides an unexpected result. As the target according to the present invention is sputtered, its erosion surface remains smooth despite the progress of erosion thereby improving the uniformity of the thin film produced via sputtering and preventing undesired generation of arcings and particles that can be produced during sputtering. For example, FIG. 4 of the present application is a diagram showing the results of measuring the surface roughness of the target according to the present invention as sputtering progresses. In contrast, FIG. 8 is a diagram showing the results of measuring the surface roughness of a conventional target as sputtering progresses. With respect to the present invention, the surface roughness remains small during sputtering; whereas, the surface roughness of the conventional target increases to at least about 3.5 times greater than that of the present invention. From Table 1, on page 13 of the present application, as filed, the examples of the present invention have an erosion face after sputtering with a surface roughness of between about 0.12 and 0.34 μm . In contrast, the surface roughness of the comparative examples is between about 0.87 to 3.52 μm .

The cited references fail to disclose this unexpected result or provide any teaching with respect to this unique property of the present invention.

Also, the sintering temperature used to produce the sintered body target of the present invention is between about 400 to 520°C (see Table 1). In contrast, Fan et al. fail to disclose a

sintered body or sintering temperature, and Nate discloses sintering temperatures well above this range which would clearly alter the microstructure produced by the sintering process.

With the amorphous alloys of Fan et al., crystallization advances "before reaching the glass transition point" in the elevated temperature process. When crystallizing the amorphous alloy, numerous nano-crystalline structures are formed since the driving force of crystallization is high and the nucleus formation energy is low. In fact, Fan et al. teaches an alloy of a state where nano-crystals are dispersed in the amorphous base material (as discussed above).

Meanwhile, with the metallic glass of the present invention, crystallization will advance only after reaching a temperature that is higher than the glass transition point. This is because, when crystallizing metallic glass, the nucleus during the crystallization will become larger in comparison to an amorphous alloy, because the driving force of crystallization is low and the nucleus formation energy is high, and because the crystallization reaction generally occurs in eutectic form. In fact, with the present invention, the overall structure is formed from crystallites of 1 to 5nm. Thus, the microstructure required by the claims of the present application is not "purely amorphous" or includes a small fraction of nanocrystals randomly embedded within an otherwise amorphous matrix of material.

In addition, with the amorphous alloy of Fan et al., since crystallization advances before reaching the glass transition point based on heating, the "glass transition" cannot be observed. Meanwhile, with the glass alloy of the present invention, the glass transition can be observed based on the elevated temperature. Accordingly, the difference between the amorphous alloy of Fan et al. and the glass alloy of the present invention can also be acknowledged from the perspective of whether or not the "glass transition" can be observed.

Thus, since the metallic glass of the present invention possesses resistivity against crystallization and has a stable structure, a sputtering target using such metallic glass is able to perform stable sputtering. In comparison with the amorphous alloy of Fan et al., the present invention is able to inhibit the generation of arcing and particles during the sputtering, and it is extremely useful on a commercial level since the uniformity of the film is stable per lot and per sputtering batch.

As described above, the glass alloy sputtering target of the present invention clearly differs from the amorphous alloys disclosed in Fan et al. with respect to its microstructure, and it would be inappropriate to view these alloys as being obvious variations. In addition, since Fan et al. fail to disclose or suggest the use of a glass alloy as a sputtering target, it would also be inappropriate to judge that the present invention is obvious based on the disclosure of the Fan et al. publication.

Nate discloses an alloy target for use in optical-magnetic recording, characterized in containing 10 to 50at% of rare earth elements, 0.1 to 10at% of additive elements such as B, and the remainder substantially being transition metals such as Co, wherein the structure is a mixed structure formed from inter-metallic compound phases of the rare earth elements, the additive elements and the transition metals.

As described above, the target of Nate clearly has a different chemical composition in comparison to the glass alloy of the present invention and the amorphous alloy of Fan et al., and it also fails to satisfy the requisite conditions to become metallic glass. Moreover, since the target of Nate is formed from a standard crystal phase structure, its structure is clearly different from the glass alloy of the present invention and the amorphous alloy disclosed by the Fan et al. publication.

For these reasons, Applicants respectfully submit that there is no common sense motivation for one of ordinary skill in the art to combine Fan et al. and Nate because they disclose different microstructures and chemical compositions. Further, Fan et al. is directed to mechanical properties of amorphous alloys, and Nate fails to provide any disclosure relative to compression tests or the like that would lead one of ordinary skill in the art to have a common sense reason to look to Nate for modifications with respect to the alloys disclosed in the Fan et al. publication. Even in the event that the teachings of Fan et al. and Nate were somehow to be combined, such combination would not lead to the present invention as recited by the claims of the present application.

Incidentally, although it is stated in the Office Action that “Nate et al. (‘095) discloses amorphous materials can be formed into sputtering targets by sintering powders of desired compositions (col. 1, lines 18-35 and col. 2, line 31- col. 4, line 68)”, Applicants respectfully submit that Nate does not provide such a disclosure. Reconsideration of this is respectfully requested. Column 1, lines 18-35, of Nate references “amorphous alloys”; however, there is simply no disclosure that these “amorphous alloys” are made via sintering powders. In addition, column 2, line 31, to column 4, line 68, of Nate references sintering with respect to producing “mixed structures” formed from different intermetallic compound phases. There is no connection between the materials disclosed in the “background art” relative to “amorphous alloys” and the method used to produce the “mixed structures” of Nate formed from different intermetallic compound phases. Thus, Applicants submit that this statement in the Office Action is in error.

Accordingly, for all the reasons discussed above, Applicants respectfully submit that independent claims 2 and 37 of the present application are not obvious over Fan et al. in view of Nate. Applicants respectfully request reconsideration and removal of the rejection.

B. In the non-final Office Action dated October 14, 2009, claims 39 and 40 are rejected under 35 USC §103(a) as being obvious over the publication of Fan et al. titled "Deformation behavior of Zr-based bulk nanocrystalline amorphous alloys" in view of U.S. Patent No. 4,992,095 issued to Nate et al. and further view of the publication of Kakiuchi et al. titled "Application of Zr-Based Bulk Glassy Alloys to Golf Clubs".

Applicants respectfully submit that dependent claims 39 and 40 are patentable over Fan et al. in view of Nate and further in view of Kakiuchi et al. for the same reasons discussed above that independent claims 2 and 37 are patentable over Fan et al. in view of Nate.

In addition, the publication of Kakiuchi et al. discloses that a Zr-based amorphous alloy possesses higher strength in comparison to an existing Ti alloy, and that such an amorphous alloy is suitable for use as a golf club material. From this teaching, it may be possible to recognize that the Zr-based amorphous alloy of Fan et al. possess similar tensile strengths as that disclosed in the Kakiuchi et al. publication. Nevertheless, to say that all other properties of these materials would be similar is clearly an overstatement not based on facts. In addition, the Zr-based amorphous alloy group cannot be acknowledged as mutually having the same properties and being capable of providing the same functions. Therefore, Applicants respectfully submit that the subject matter of claims 39 and 40 of the present application would not be obvious to one of ordinary skill in the art based on Fan et al., Nate and the Kakiuchi et al. publication.

Accordingly, Applicants respectfully request reconsideration and removal of the rejection of claims 39 and 40.

No New Matter Added to Amended Claims and New Claims

With respect to “sintered body” and “ultrafine and uniform crystal structure” in claims 2 and 37, these limitations are disclosed on page 1, lines 7-8, and page 8, lines 13-17, of the present application, as filed.

With respect to the amendment of claim 40 and the subject matter of new claim 41, see page 9, lines 2-12, of the present application, as filed.

With respect to the subject matter of claim 42, see page 5, line 30, to page 6, line 3, of the present application, as filed.

With respect to the subject matter of claim 43, see page 8, lines 5-12, and page 13, Table 1, column “SPS Temperature °C” for Examples 1-6 of the present invention.

With respect to the subject matter of claim 44, see page 10, lines 1-2; FIG. 4 and its description; and page 13, Table 1, column “Surface Roughness μm ” for Examples 1-6 of the present invention.

Conclusion

In view of the above amendments and arguments, Applicants respectfully submit that the rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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